ERDC/CRREL TN-04-1

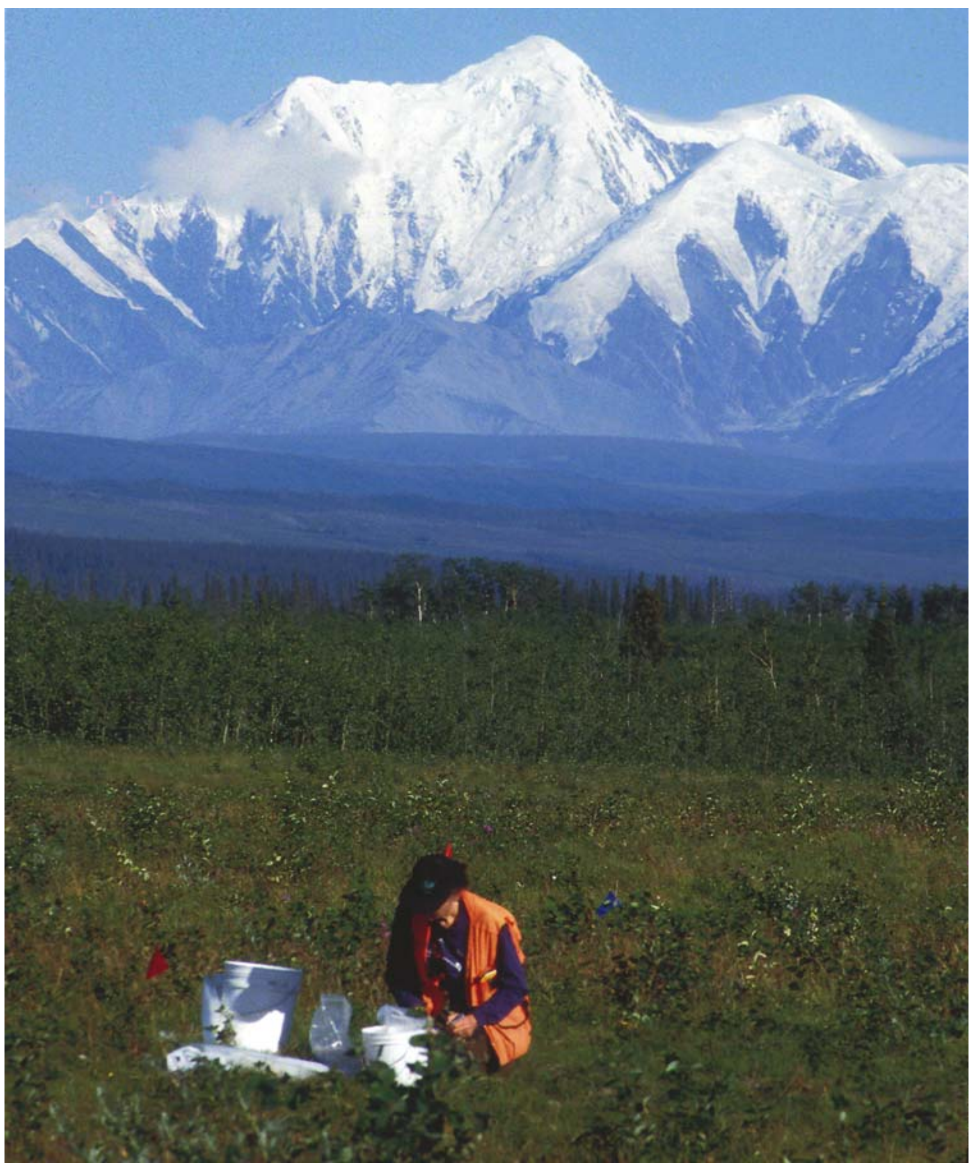
Cold Regions Research and Engineering Laboratory

US Army Corps of Engineers®
Engineer Research and Development Center

Field Sampling Tools for Explosives Residues Developed at CRREL

Michael R. Walsh

April 2004



Front cover: Field processing of soil samples on Firing Point Sally, Donnely Training Area, Alaska, July 2002.

ERDC/CRREL TN-04-1
April 2004

Field Sampling Tools for Explosives Residues Developed at CRREL

Michael R. Walsh

Prepared for U.S. ARMY CORPS OF ENGINEERS

ABSTRACT

Characterization of active military ranges is critical to the sustainability of training lands for the United States Military. An important element in this characterization is the determination of explosives residues resulting from both live fire and disposal of dudded munitions on these ranges. The U.S. Army Cold Regions Research and Engineering Laboratory has developed a suite of tools for use in sampling for residues in both soils and snow. These tools are lightweight, rugged, and easy to clean. Through extensive field use, they have been optimized for ease of use and sample accuracy. This Technical Note describes these tools and their use in different environments.

CONTENTS

ILLUSTRATIONS

PREFACE

This report was prepared by Michael R. Walsh, Mechanical Engineer, Engineering Resources Division, U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), Engineer Research and Development Center (ERDC), Hanover, New Hampshire. Technical review was provided by Dr. Thomas F. Jenkins, Research Chemist, and Marianne E. Walsh, Chemical Engineer, Environmental Sciences Branch, CRREL.

Funding was provided by the Strategic Environmental Research and Development Program (SERDP), Arlington, Virginia, Bradley P. Smith, Executive Director, and Dr. Jeff Marqusee, Technical Director, under Compliance Project Number CP1155.

The Commander of the Engineer Research and Development Center is COL James R. Rowan, EN. The Director is Dr. James R. Houston.

Field Sampling Tools for Explosives Residues Developed at CRREL

MICHAEL R. WALSH

1 INTRODUCTION

The characterization of active military ranges is a critical concern for Army range managers. Recent lawsuits have sharpened our awareness of the ramifications of incomplete knowledge when dealing with munition constituents on training ranges. Of primary concern are the quantity, persistence, and mobility of the explosives and the by-products of their detonation on groundwater. Characterizing the sources of this possible contamination begins with careful and thorough sampling.

The U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory (CRREL) and Environmental Laboratory (EL) have worked over many years developing sampling techniques for explosives residues. As part of this process, a number of sampling devices have also been developed. These devices have been evolutionary and are still being improved. In our work, sampling takes place in two very different environments. This report describes the tools currently in our arsenal and how we use them in the environments for which they are designed.

2 REQUIREMENTS

The requirements for the sampling tools developed by CRREL have evolved over time. Initially, sampling took place only in summer on dry soils. Later, sampling on snow- and ice-covered ranges was conducted, presenting a vastly different sampling scenario. Although the basic requirement of the tools remains the same, the application in contrasting environment led to two sets of tools.

The substances of interest in our research are initially deposited into the environment in particulate form. Sampling is thus concentrated on land areas, although some work with water is involved (sediments and sediment flow). For the purpose of this Technical Note, only sampling on land is considered.

Two methods of sampling are widely employed, discrete sampling and composite sampling. Discrete sampling usually involves a single, large-volume sample taken from a limited number of locations in the area of concern. Composite sampling involves combining a large (usually >30) number of small discrete increments over the complete area of concern. An area can also be subdivided and a number of composite samples taken.

In non-winter environments, the objective is to collect soils that may harbor the contaminant. Soils can be cohesive or loose, requiring different approaches to the collection of the samples. The weight and difficulty of handling, processing, and analyzing a large amount of soil samples compels the use of compositing to characterize a site. Small, very rugged, easy-to-use tools are thus required. These tools must also be easily transported to and on the site and easy to clean. Interchangeability in the field is desirable in case the subsample size needs to be altered or a part of the sampler breaks. In the case of cohesive soils, the ability to obtain a soil plug is critical, as well as the ability to remove the plug intact for possible division into depth increments. For non-cohesive soils such as sand or gravels, obtaining uniform samples is the most difficult requirement.

Winter sampling requirements are similar but under very different conditions. The sampling methods developed for winter tests entail the collection of mixed snow and residue samples within the visible plume of a detonation. Separate samples from the detonation point may also be collected. If the snow is underlain by ice and the area of the detonation has not been used that winter prior to the test, the test conditions are essentially pristine and no cross-contamination from previous tests is present. Thus, for sampling in winter, scoops are the tools of choice. Again, the tools must be lightweight, easily transported, and simple to clean.

Residue Collection Tools

Over the last five years, CRREL has concentrated on the manual collection of residues from active ranges. Thus, the focus of our development efforts has been on hand tools. A study of collection strategies has paralleled our research on explosives residues. The objective of the study is to devise a collection strategy that will minimize the number of samples required for a representative characterization of an area or event. A robust composite sampling strategy is the goal.

For composite sampling, many small subsamples are combined into one sample for analysis. The tools, therefore, will be small and easy to handle. The sampled media for the two seasons are different enough that most of the tools will be specific for a particular season. Tools for use during summer will be discussed first.

Soil Samplers

Several commercial tools for sampling soils that approximated our needs were available at the start of our work. These included various-size sample scoops, light-duty bulb planters, and small coring devices. The shortcomings of these tools quickly manifested themselves. The bulb planter handles snapped off. They were not designed for use in the compacted and rocky soils where we used them. The coring devices were too small and difficult to clean. And the scoops gave inconsistent sample amounts. New tools were needed.

The tools developed for cohesive soils sampling are shown in Figure 1. The two sampling heads in the foreground are replacements for the flimsy commercial bulb planter. The cutter heads are machined from 2-1/4-in.-OD × 3/16-in.-wall seamless stainless steel tube. They are designed to take 4.75-cm-diameter cores that are up to 12 cm long. These are welded to 1-1/4-in. stainless steel angles. A 1-1/4-in.-OD × 1/4-in.-wall extension is also welded to the angle to mount the Schedule 40 steel handle extension, shown at the back. The handle is shown in the rear left. The shaft is made of 1/2-in. Schedule 40 aluminum tube with a 3/4-in. Schedule 40 cross-piece. Cottered or self-locking 0.8-cm (5/16-in.) pins are used to assemble the tool. Parts are designed to be interchangeable and fit in a 36-× 56-cm shipping container (Rubbermaid ActionPacker).

The two corers in the center of the image are designed to take smaller samples. Each has an adjustable stop that can also be used to eject the core from the cutter. The corer on the right will take a 2.8- × 7.6-cm-long core, the one on the left a 4.5- × 7.6-cm-long core. Core depth is adjustable with the stop. The larger unit is designed for use with a 120-mL widemouth jar and can be used as both a discrete sampler and a composite sampler. The smaller unit is designed so

that 30 increments that are 5 cm long can fit in a 2-L widemouth bottle. The aluminum handle is used with these corers.

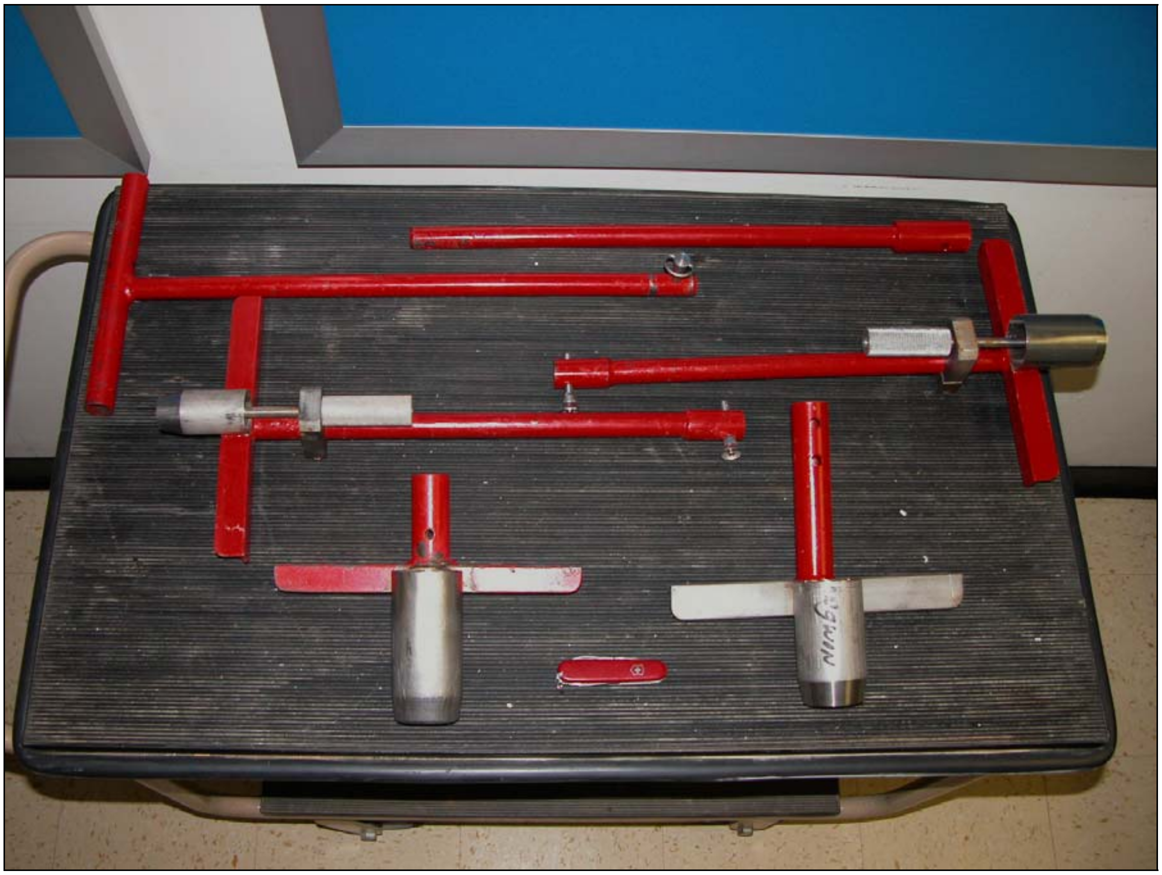


Figure 1. CRREL coring tools for cohesive soils.

One feature of the larger corers is the ability to stratify cores. When coring in vegetated areas, the core can be pushed out slowly and the zones (vegetative mat, root zone, soil) can be separated using the toothed putty knife in Figure 3. This allows separation of soil zones in composites or the ability to discard unwanted or excess core, thus reducing the sample size.

All the corers are easily cleaned in the field using the items in Figure 2. The 4-L jug with the spray head contains acetone for rinsing the cores between discrete or composite samples. The wire brush and stainless steel wool is used to address persistent spots on the tools. Lab-grade wipes are used for wiping the tools down. The handles to the stops of the smaller corers are easily removed to thoroughly clean the inside of the corer.

Figure 2. Field cleaning supplies and equipment.

Figure 3 depicts tools used for non-cohesive soils, such as sand or gravel. The device to the rear of the image is called a cookie cutter. It forms a 4.5-cm-diameter by 2-cm-high puck when placed on the ground and twisted. The puck can then be scooped into the compositing bag with one of the stainless steel sample scoops (AMS Part numbers 428.02–06). Not shown is a hammer corer available from AMS (Part number 404.61) that is used to obtain short (<12-cm) cores in very rocky soils. This is an all-stainless device with which we have had very good results.

Figure 3. Non-cohesive soil sampling tools.

Snow Samplers

Sampling soils for residues is a very effective way of characterizing a site but is not suitable for characterizing a detonation event. The problem lies with the unknown contamination of the soils prior to the event to be sampled. This is especially problematic with live-fire events, which typically occur in heavily used impact areas. When the round detonates, it is often difficult to find the exact location of the detonation point and, even when the detonation point is found, the presence or absence of prior contamination is not known. Even with rounds detonated with non-standard initiators, the background levels of explosives can be difficult to measure. To ensure a clean test, all materials within the area to be sampled must be removed and replaced with clean material, and the depth of clean material beneath the detonation point must be sufficient to prevent the lofting of any residual contaminants from any previous detonation at that point.

We have found that the most effective strategy for sampling discrete detonations from both live-fire and rounds statically detonated (blown-in-place, or BIP) is to use an ice-covered area that is covered with a thin layer of snow. This area must not have been fired into since ice formation. With sufficient ice cover, rounds will not penetrate and samples obtained will contain only detonation residues and frozen water. The ice and snow cover thus provides a pristine environment within an impact area, ideal for sampling.

Current practice is divided into two strategies: Obtaining several (15–30) large-area (m^2) discrete samples or a few (1–3) multi-increment composite samples for each event. The tools differ for the application. For large-area discrete samples, a PTFE-coated aluminum snow shovel is used (Fig. 4). This shovel has the upper corners bent in to facilitate loading the sample bags. There is no depth control to achieve the 2- to 3-cm depth required for a standard sample. The sampling area is demarcated by outlining the area with the shovel blade, which is 46 cm in length. Remnant residue in the 1-m^2 sampled area is cleaned up using one of the small stainless steel scoops shown in front of the shovel.

Figure 4. Snow sampling tools.

Composite samples are collected using either a 10-cm, 15-cm, or 20-cm square PTFE-lined aluminum scoop (Fig. 4, front right and left). These scoops have a 2-cm-high edge to help gauge the tool depth while taking a sample. The scoops are lightweight and easy to use and clean. A commercially available 10-cm stainless steel scoop is shown behind the 20-cm scoop.

In addition to collecting residues from the surface using scoops, we have also used pre-placed trays when sampling BIPs. The trays are 43 × 63 cm with a 3-cm rim. We have used them on both soil and snow, at detonation locations and firing points (Fig. 5). When used during winter tests, they are very effective at collecting particles for later analysis. They also work well in summer, although dust and some soil is inevitably deposited on them following detonation. They were very useful when used to recover small whiskers from the propellants used when firing howitzers during a winter live-fire test.

a. Placing trays prior to firing.

Figure 5. Collection of propellant residues using trays at a snow-covered firing point.

b. Trays in use during a live-fire exercise.

Figure 5 (cont'd).

There are problems with using trays. Trays currently used are the equivalent of the large discrete samples taken on snow. It is impractical to put a large number of them out to obtain a wide coverage of the area affected by the round detonation. The other problem is with live-fire exercises. The trays must be pre-placed, but there is no certainty as to where a round may land, especially a mortar round. There are proposed solutions to both these problems, but we have yet to have the opportunity to try them.

Use of Tools in the Field

All the tools shown above have been used successfully in the field. The coring tools have been both reliable and easy to use. They are robust enough to use in rocky soils (Fig. 6), where previous devices have failed. Cores are easily extracted and can be accurately cut in the field. Cleaning of the tools is quick.

a. Assembled corer.

Figure 6. Using a cohesive soil sampler in the field.

b. Plug sample from the corer. Note soil gradations.

Figure 6 (cont'd).

The snow sampling tools have been used extensively in tests in Alaska. The shovels are effective but difficult to use. The sample bag used is slightly smaller than the shovel, making placement of the sample in the bag difficult. The depth of the sample is also difficult to control. Tests indicate that spillage during sampling or insufficient sampling depth can result in underreporting of contamination of up to 15%. Sampling is quick but not as accurate as we would like (Fig. 7). The shovels are easy to clean.

Figure 7. Sampling a 1-m^2 area of snow next to a detonation point.

The scoops are very easy to use and quite effective when taking composite samples (Fig. 8). It is easy to gauge depth, ensuring a complete sample is taken. There is no spillage when placing the sample in the compositing bag. They are lightweight and easy to clean. In some cases, the 20-cm scoop has been used in difficult locations to acquire the large (m^2) discrete samples. They do a thorough job, but are slow.

Figure 8. Composite sampling on snow with a 20-cm tool.

3 ASSESSMENT

The tools developed by CRREL for explosives residues sampling have been valuable assets in our range contamination and sustainability studies. They have evolved as sampling strategies have been optimized, allowing us to take advantage of improved sampling methodologies. Sampling is now much easier and efficient, and sample quality has improved in part due to the new tools. Although the basic designs have been established, work is continuing on optimizing the tools for field use.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
April 2004	Technical Note	

4. TITLE AND SUBTITLE

Field Sampling Tools for Explosives Residues Developed at CRREL

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Michael R. Walsh

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

U.S. Army Engineer Research and Development Center
Cold Regions Research and Engineering Laboratory
72 Lyme Road
Hanover, NH 03755-1290

8. PERFORMING ORGANIZATION REPORT

ERDC/CRREL TN-04-1

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR / MONITOR'S ACRONYM(S)

11. SPONSOR / MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

Available from NTIS, Springfield, Virginia 22161.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Characterization of active military ranges is critical to the sustainability of training lands for the United States Military. An important element in this characterization is the determination of explosives residues resulting from both live fire and disposal of dudded munitions on these ranges. The U.S. Army Cold Regions Research and Engineering Laboratory has developed a suite of tools for use in sampling for residues in both soils and snow. These tools are lightweight, rugged, and easy to clean. Through extensive field use, they have been optimized for ease of use and sample accuracy. This Technical Note describes these tools and their use in different environments.

15. SUBJECT TERMS

Explosives residues; Sampling; Sampling tools; Snow and ice; Soils

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON / 19b. TELEPHONE NUMBER *(include area code)*
U	U	U	U	22	